A Matter of National Competitiveness

By

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Good morning. Thank you, Ms. Lisa Gutierrez [Diversity Office Director], Dr. Allen Hartford [Science and Technology Base Program Director], and Dr. Alan Bishop [Theoretical Division Director]. Thank you for that warm introduction. I am delighted to be here with you today. Let me congratulate you on having successfully weathered some unusually exciting months.

The subject this morning – minorities in science – is one that I have lived personally and that frequently I am asked to address. I am pleased to do so. We live and work in a period of history when this is a valid topic of learning and discussion. However, I look forward to a time in the future when this topic will no longer be considered a matter for discussion at all. It will be the same time that Dr. Martin Luther King Jr. dreamed of when " . . . children would be judged not by the color of their skin, but on the content of their character . . ." When that time arrives, our subject for the morning will be simply "people in science." It will be a time when the population of professionals in science, engineering, and mathematics will mirror the mosaic composition of the population.

For the present, however, this issue remains a matter of legitimate national concern. The reason why this is a matter of interest is that the exponential increase of scientific and technological advances, in conjunction with society's equally exponential reliance upon these advances, require that we assure an adequate supply of trained and educated scientists for the future.

Our responsibility as practicing scientists and as leaders in this globally competitive era is to assure a full flow in the pipeline of future scientists and engineers who have the interest and motivation to pursue advanced education and research. My message today is that increasingly, our comprehensive global competitiveness will demand the full participation of women and minorities in science and engineering if we are to benefit from their contributions.

To understand this topic, let us explore what happens when a society discourages the contributions of some segments of its population. I will provide a context by relating the stories of several scientists of the past who despite numerous obstacles were able to contribute in their fields**.** I will add to that several contemporary scientists who may or may not be known to you. Next, I will discuss the vast need we have for educated and trained scientists, review the barriers that exacerbate this need, and finally focus on what we must do about it.

It is a challenge to choose examples out of the number that are available. Nevertheless, let us look, first, at **Elijah McCoy** [1843 – 1929], who was born in Colchester, Ontario, to American parents who had traveled on the Underground Railroad to escape slavery in Kentucky. Early in life, the young Elijah McCoy showed an aptitude and interest in mechanical devices. His parents recognized this special talent and sent him to study in Edinburgh, Scotland, where he became a full-fledged engineer.

McCoy then came to America seeking employment as an engineer. In the 1860s, professional jobs were usually not available to African-Americans, so McCoy settled for a position as a fireman and an oilman for the Michigan Central Railroad. The technology available at the time made it necessary to bring locomotive engines to a halt while mechanics lubricated the machines. Elijah McCoy developed a self-lubricating device that worked while the locomotive was <u>in motion</u>, eliminating the need for engine downtime. The “lubricator cup” as he called it, was adapted for use in all manner of equipment and became so sought-after that, soon, no equipment was considered adequate without it. It may have given rise to the phrase, "the real McCoy," though historians differ on the origins of this American cultural idiom.

Ultimately Elijah McCoy received 30 patents for oil lubricating systems for different types of machines. For nearly 45 years between the 1870s and 1915 most of the railroad locomotives in the US were equipped with Elijah McCoy's lubricators.

Another prolific inventor was **Jan Earnst Matzeliger** [1852 – 1889] [pronounced YAN] born in the South American Dutch colony now known as Surinam. With little formal education, Jan Matzeliger sailed on a merchant ship for Philadelphia in 1872, eventually migrating to the Boston area in 1876. There he found employment in a shoe factory. Purchasing physics books with the little money he earned, Jan Matzeliger studied and worked nights assembling a machine that could automatically stitch shoe leather to the sole of the shoe – the first "shoe lasting machine."

He continued to improve the model and was granted a patent. The device lowered the cost of making shoes by 45 percent and increased shoe production. A similar concept is still in use today.

Known as the Black Edison, **Granville T. Woods** [1856-1910] was a prolific inventor and pioneer of the Industrial Revolution. Born in Columbus, Ohio, in April 1856, Woods was a free man thanks to the 1787 Northwest Ordinance that disallowed slavery in the territory that became Ohio.

But Ohio was one of the first non-slave states to invoke the Black Laws that effectively prohibited movement by Blacks in the state through the use of curfews and hiring practices. So, the young Granville Woods went west to Missouri and got a job as a fireman-engineer with the Iron Mountain Railroad. Interested in learning about electricity, he poured through every book he could find on the subject from friends, employers, and the local library. Eventually he went east to study electrical and mechanical engineering, and in 1878 he signed on as an engineer on the

Ironsides, a British steamer. By 1881 he had earned enough money to open Woods Electric Company in Cincinnati which made telephone, telegraph and electrical equipment. And with a company to support his work, he worked on many useful inventions.

Among them:

- A telephone transmitter with more range than that which had been available carried voices over longer distances with greater clarity and improved sound.
- His “telegraphony” allowed telegraph stations to send messages via Morse code and orally over the same line. American Bell Telephone Company in Boston purchased the invention.
- A synchronous multiplex railway telegraph allowed messages to be sent to and from moving trains. The device conducted messages via static electricity to the telegraph wires running alongside the tracks without interfering with normal telegraphic communications and could warn trains of hazards on the tracks ahead.
- A safe, consistent dimming system for theaters lessened the risk of fires and reduced energy consumption by about 40 percent.
- An overhead conducting system for the railroad, replacing expensive and inefficient steam-driven engines with clean, efficient electric trains. It is still in use today with streetcars and trolleys; and a third rail system still in use on many city subway tracks.

In all, Granville Woods was awarded more than 35 patents for his electrical inventions and more than 150 patents over all. A number of his inventions were sold to the General Electric Company, Westinghouse Air Brake Co., and American Bell Telephone Company. Thomas Edison tried to hire him, but he declined.

A last example is **Garrett Augusta Morgan** [1875 – 1963] born in Paris, Kentucky, in 1875, the seventh of 11 children of former slave parents of mixed African-American and Native American background. Morgan left school in the fifth grade when he was 14 years old, barely literate, and penniless, traveling to Cincinnati where he found employment fixing sewing machines. Fascinated with mechanical workings, Garrett Morgan quickly learned the principles of the appliances. Eventually moving to Cleveland, he invented a fastener for the sewing machine drive belt that simplified its operation which he sold for a fraction of its worth. The sale of the device enabled him to start a sewing machine and dry goods business and continue to invent useful items.

Watching firefighters battle a local fire inspired Garrett Morgan to study the scientific principles of combustion and in 1912 devise what he referred to as a “breathing helmet.” Complete with a transparent plate and hearing tubes, the helmet was portable, fire resistant, waterproof, and drew cooled air up from the ground level where it remained relatively smoke and fume free. This was adopted by firefighters and successfully used to save lives. Garrett Morgan modified the design later so that the device could carry its own air supply. The concept was further improved and used successfully by the U.S. Army during the First World War.

The invention that Garrett Morgan is most remembered for is an automated traffic signal. One day at a busy intersection, Garrett Morgan saw an automobile collide with a horse drawn carriage. Garrett Morgan studied traffic patterns to better understand the problem, set objectives, and worked to transform ideas into reality. In 1923, Garrett Morgan received a patent for his device that would provide a visible indicator that revolutionized traffic control at a time when rules governing behavior at intersections were just beginning to evolve.

These African-American scientists, engineers and inventors distinguished themselves and made substantial contributions to the betterment of society in spite of a system that, at the time, actively discouraged their talents. Collectively, their stories beg the question, where might we be had talent in all colors been encouraged?

We are fortunate today that those old systems are no longer in place, having been relegated to history. Nevertheless, our society today still faces challenges in this regard, and we still have work to do.

The minority scientists of history are joined today by others who today are likewise contributing to the advancement of science, the quality of life, and the betterment of human kind.

- There is **Dr. Ben Carson** who was born in the projects of Detroit, a pediatric neurosurgeon at Johns Hopkins University Hospital who pioneered the surgical separation of Siamese twins joined at the head and who also has made tremendous strides in the use of hemispherectomies to treat severe neurological disorders in children.
- There is **Dr. Roscoe Koontz,** one of the first formally trained Health Physicists, who made significant advanced in radiation detection instrumentation, environmental sampling equipment, and survey techniques to protect humans from the dangers of ionizing radiation.
- There is **Dr. J. Ernest Wilkins, Jr.,** also a physicist and mathematician, who conducted determining research in radiation absorption and radiation shielding, as well as helped to design and develop nuclear reactors for electrical power generation.
- There is theoretical physicist **Dr. Walter Eugene Massey**, who, in addition to seminal research dealing with many-body problems, quantum liquids, and quantum solids, also served as the Director [and later as the Vice President for Research] of Argonne National Laboratory, and the Vice President of the University of California system, and the Director of the National Science Foundation.
- There are many others.

There is no doubt that the experiences of these African-American scientists of today differ from those who were born in the 19th century. Yet, I believe it is safe to say that minority scientists today make their many and significant contributions to the general advancement and welfare of humankind <u>also</u> in spite of major challenges, though perhaps of a somewhat different kind. Their challenge is what I term an educational gap complicated by the digital divide -- both of which we must acknowledge and address.

Consider, for a moment, both how the United States measures up to other industrialized nations as well as how specific groups compare within our student population.

- We know that as a whole, U.S. students in math and science lag behind students in half the other industrialized nations.
- We know that the overall U.S. dropout rate is between 25 and 30 percent, according to new statistics from the Harvard Graduate School of Education.
- We know that there is a disparity in achievement measured by average scores on the National Assessment of Education Progress Tests. In math, although the gap between minority and other students had been reduced by half between 1973 and 1990, in the last 10 years it actually widened by 50 percent, and stood at 31 points in 1999. In science, the achievement gap is even larger, and, at 52 points, is nearly as large as it was in 1969.
- We know this is not exclusively a problem for inner cities or declining neighborhoods. Among 7th graders in the affluent college town of Ann Arbor, Michigan, only 34 percent of black children received scores of satisfactory or better in mathematics, compared to 83 percent of others.
- In engineering, we know the latest statistics from the National Action Council for Minorities in Engineering (NACME). NACME latest figures find that the number of engineering graduates is the third smallest over the past 20 years and that minority growth is the lowest since 1989 in both percentages and in real numbers. Last year, U.S. engineering institutions produced slightly less than 2 percent more graduates than they did in 1999. Minorities among the graduates increased less than 1 percent in the same time period, and of that number, the

number of Native Americans and Hispanics increased slightly, while African-Americans declined slightly.

Now add to these figures regarding basic education for our national student body the statistics describing the other divide – the digital divide.

In the past decade, studies have shown disparity between whites and minorities both in terms of computer ownership and Internet access. The Commerce Department has conducted a series of four studies called "Falling Through the Net." The latest report, issued last October, shows that Americans are now more connected than ever. More than half of all American households [51.0 percent] now own computers. That is up from 42.1 percent two years ago.

The report examines Internet access not by household, as it had done in the past, but by individuals. The study found that the share of individuals using the Internet rose by a third, from 32.7 percent in December 1998 to 44.4 percent in August 2000. If growth continues at that rate, more than half of all Americans will be using the Internet by the middle of this year.

That is good news. And, there is more. Groups that have traditionally been digital “have-nots” are making dramatic gains. The gap between households in rural areas and households nationwide that access the Internet has narrowed from 4.0 percentage points in 1998 to 2.6 percentage points in 2000.

Blacks and Hispanics still lag behind other groups. Nonetheless, these groups have shown impressive gains in Internet access. Black households are now more than twice as likely to have home access than they were 20 months ago, rising from 11.2 percent to 23.5 percent. Hispanic households have also experienced a tremendous growth rate during this period, rising from 12.6 percent to 23.6 percent.

And while these rates of growth, too, are good news, the digital divide regarding computer ownership and Internet access remains or has expanded in some cases. The Commerce Department reports states that, “divides still exist between those with different levels of income and education, different racial and ethnic groups, old and young, single and dual-parent families, and between those with and without disabilities. Blacks and Hispanic households continue to experience the lowest Internet penetration rates at 23.5 percent and 23.6 percent respectively. In addition, the divide between Internet access rates for Black households and the national average was 18 percentage points in August 2000 [a 23.5 percent penetration rate for Black households compared to 41.5 percent for households nationally]. That gap is 3 percentage points wider than it was in December 1998.

For Hispanic households, the national average Internet divide was 18 percentage points or 4 percentage points wider than it had been 20 months before.

Finally, let us consider why this is important and what it means. These twin divides cannot help but compound each other, and the net effect seriously challenges our national competitiveness.

The National Science Board, which oversees the National Science Foundation, concludes in a study released last year that a drop in science enrollment threatens the U.S. economy. The Board report notes that enrollment in graduate-school level science programs declined each year from 1993 to 1997 — following four decades of annual growth.

Over this 1993 to 1997 period, graduate enrollment in science and engineering dropped 6.5 percent, from approximately 435,000 students to 408,000 students. Part of the drop has been attributed to the decline in foreign-born Ph.D. candidates (15 percent in 1997, marking the first such annual decline in a decade).

The same study also reports — and this is the demographic adjunct to the challenge — that only five percent of graduate students in science programs are African-American and fewer than four percent are Hispanic. Women continue to be underrepresented in this group, as well, at 40 percent in 1997.

This under-representation exists along side predictions that, although college enrollment will rise 10 to 20 percent over the next decade or two, 80 percent of this increase will come from demographic segments traditionally least well represented in scientific fields — women and minorities.

In fact, a 1998 report by the National Information Technology Workforce Convocation cited a shortage of 346,000 information technology workers. And, according to Department of Labor projections, 60 percent of American jobs in the coming years will require skills that only 20 percent of Americans have.

This is reflected by the situation in information technology-related fields alone. Between 1995 and 1998, the "Internet economy" grew at a compounded rate of 174.5 percent, compared with 2.8 percent for the U.S. economy overall, with 1998 revenues of $301 billion. Yet, our country's technology-based industries cannot meet their employment needs, which is why each year, companies seek to increase the number of visas issued to technologically trained workers from other nations.

The Internet economy, currently perhaps, appears less sunny than it has in the recent past. However, even if the Internet economy cools, technology will continue to be the major driver of the economy. Advances in and new uses of Information Technology, data mining, and data warehousing continue daily. The value of easily accessed and conveniently formatted information remains extremely high. In another arena, advances in Biotechnology promise medical therapies, food supplies, life span enhancement, and more. The ever-advancing march of technology creates opportunity to solve long-standing and <u>new</u> societal and global problems. But only if we have the talent to deploy.

So, to come to closure, there are two facts that I would like to juxtapose:

- First, we know that on the employment market, one out of two new technology jobs goes unfilled in the United States today.

- Second, we know that in 50 years there will most likely be no single majority group in the United States.

It follows, therefore, that it is in our best interest – indeed, it is in our national interest – to assure the full participation of each and every student, to improve basic mathematics and science education, and to find new methodologies that will encourage all students – especially our minority and female students. They are a vast and under-developed human resource for our new technology economy.

Our nation – and the world – are embarked on perhaps the greatest technological revolution ever experienced. Yet, unless all children – and especially women and minority students – are intellectually prepared to participate fully, this revolution will leave substantial proportions of our population behind and our national advancement cannot help but decline. This threatens the very stability of our society, not to mention its continued economic prosperity.

The past has shown us that when we do not attend to basic and higher education, training, and the full utilization of all segments of our population, we risk wasting some of the best talents and resources we have been given.

I contend that working toward our collective future should be our <u>collective</u> goal because it is in our enlightened self-interest, it is critical for our national security, and it will assure the future, indeed, of our world.

Those of us in the science/engineering/ mathematics community, as both makers of this revolution and as the beneficiaries of it, must continue to help bridge the educational divide, lead efforts to improve the education infrastructure, and upgrade an antiquated educational power-grid. There is no greater challenge today.

As I close, I ask you to imagine a world in which all barriers to achievement in science, mathematics, and engineering were dissolved and then from that I ask you to imagine the benefit to humankind that would unfold. When we give all of our young people every advantage and every encouragement and every opportunity, we expand the universe.

Thank you. I will be happy to address any questions you may have.

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Solving a Complex Equation:
the Future of the National Laboratories and the Role of the DOE

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Good afternoon, ladies and gentlemen. I am pleased and honored to be here, at the invitation of your Director, to discuss my perspective on the future of the national laboratories and the role of the Department of Energy (DOE). I need not tell you that I have been assigned a topic with multiple aspects – and I would remind you at the outset that I am by trade a physicist, rather than a prophet. When you give a physicist a crystal ball for analysis, she well may decide to begin the process with a hammer, to break the problem into its constituent parts before seeing how it reassembles. In that spirit, I have entitled my presentation “Solving a Complex Equation: the Future of the National Laboratories and the Role of the DOE.”

Many of you, I suspect, have been here at Los Alamos long enough to survive the attempts to dismantle or restructure the DOE early in the Reagan Administration, and again during the 104th, 105th, and 106th Congresses. Most of you probably are familiar with the analysis of the 1999 Rudman Report on DOE security concerns, the 1995 Galvin Report on alternative futures for the DOE national laboratories, and a host of similar studies, together with the extended dialogue among legislators, members of the Administration, safety regulators, academicians, and other Federal agencies – all with the intent of restructuring, refocusing, downsizing, eliminating, or enhancing in some manner the Department and the national laboratories. At the risk of oversimplifying, I would suggest to you that each of these efforts can be summed up in three basic, interrelated elements: mission, organization, and economic investment. How should the mission of the DOE and the national laboratories be defined? What is the optimal organizational structure to ensure the ongoing success of that mission? And how should we prioritize the U.S. economic investment in these areas – which elements of the DOE mission and organization are tied most closely to our national interests, and therefore should receive the greatest emphasis?

Each of these elements of our equation – as well as the decision-making process for solving it – is in itself complex. The DOE mission is a conglomerate of objectives related to national security, energy supply, science and technology, and environmental restoration. The DOE organizational structure – despite the praiseworthy efforts of Secretary Richardson and his predecessors – is an elaborate web of reporting relationships, internal and external oversight groups, long-term contracts with the universities that administer the laboratories, and partnerships with private industry, research institutions, and other Federal agencies. The economic priorities reflect this complexity of mission and organization – and continue to evolve with changes in the political landscape, shifts in national security emphases, tightening or loosening of Federal budget constraints, and trends in the global marketplace. As we begin a new Administration and a new Congress, the debate over the DOE and the national laboratories is likely to continue, with new legislative proposals and hearings on at least some of these elements.

When President Clinton, in 1995, appointed me as the Chairman of the Nuclear Regulatory Commission (NRC), I never thought of myself as a politician. But my tenure as NRC Chairman, together with my background in research and academia – including work with several of the national laboratories – has given me some perspective on this complex issue from a policy, an organizational, and a technical point of view. I will not presume to solve the entire equation today; however, within the time allotted, I would like to examine what I believe are key "lessons," both historical and more recent, that should inform the current debate, suggest crucial considerations for the decision-makers, and provide points of focus for the management at the DOE and the national laboratories as they proceed toward an uncertain future.

I. Inter-Sector Partnerships: the Lesson of World War II

The first lesson takes us back 5 _ decades to a strikingly relevant policy document, compiled in response to a November 1944 letter from President Franklin D. Roosevelt to his director of the wartime Office of Scientific Research and Development (OSRD), Vannevar Bush. A former Dean of Engineering at the Massachusetts Institute of Technology (MIT), Bush had been appointed already as the head of the recently formed National Defense Research Council (NRDC), and had been serving as a principal science advisor to the President on the wartime mobilization of scientific expertise and research applicable to defense purposes. The letter from President Roosevelt asked Bush, in essence, to evaluate how the experience of OSRD might be applied to peacetime scientific pursuits, including R&D cooperation between public and private organizations.

The resulting report, entitled "Science—the Endless Frontier," was a pivotal document in shaping our subsequent national approach to basic and applied scientific research. The OSRD system had been highly decentralized; rather than conscripting civilian scientists and engineers into military settings, Bush and his associates had worked as liaisons, creating partnerships between the Federal military bodies and the academic and industrial organizations. This system of collegial partnerships proved highly effective: scientists collaborating at the Radiation Laboratory at MIT developed and refined the use of radar; in Oak Ridge, Tennessee, a facility managed by General Electric successfully separated out Uranium-235; and here, in the top-secret confines of nuclear bomb research at Los Alamos, the facility was managed by the University of California under an Army contract.

These early experiences highlighted a fundamental principle, articulated in the Bush report – that partnerships among the three research sectors of government, industry, and academia could achieve far more productivity, and could adapt much more rapidly to shifting national priorities, than if each sector pursued its objectives in isolation. Research could achieve greater effectiveness if the scientists were insulated from political processes. The report argued strongly that the Federal government even in peacetime should view as its responsibility the support of non-profit research institutions, as well as the development of aspiring scientists and engineers through scholarships and grants.

This principle continues to be as relevant today as during the Roosevelt and Truman administrations. Collaboration – across sectors, across Federal agencies, and across international boundaries – allows researchers to leverage their resources, and enables projects that might not have been achieved otherwise. A series of laws passed in the last two decades – including, for example, the Stevenson-Wydler Technology Innovation Act of 1980, the Federal Technology Transfer Act of 1986, and the National Cooperative Research and Production Act of 1993 – have encouraged these inter-sector partnerships and the strategic and economic benefits they produce.

The impact of these collaborative efforts can be far-reaching. The most dramatic example may be the creation of the Internet, which began, as many of you know, with a project funded by the Defense Advanced Research Projects Agency (DARPA), and was extended through university research funded by the National Science Foundation (NSF). Many other examples illustrate the symbiotic nature of government/industry/ academic partnerships. As Los Alamos Director Browne discussed last February in testimony before the Senate Committee on Energy and Natural Resources, the Accelerated Strategic Computing Initiative (ASCI) is just one example of a government program that simultaneously can advance the technology frontiers of private companies and assist the weapons laboratories in the essential validation of computer models. Similarly, at Rensselaer Polytechnic Institute, our ongoing interaction with the national laboratories has helped to produce advances in high performance computing for modeling and simulation. In a current proposal, the Rensselaer Center for Directed Assembly of Nanostructures, working with the University of Illinois at Urbana-Champaign (UIUC), and drawing on the computational resources and expertise here at Los Alamos, hopes to solve basic scientific problems that would allow the assembly of nanoscale building blocks to create functional nanostructures for practical application. Each of these examples illustrates not only the benefit to the organizations directly involved, but the development of technologies that can be expanded upon throughout each of the three sectors.

II. Separation of Functions: the Lesson of the Atomic Energy Commission

The second lesson arises from reviewing the evolution of organizations that were the predecessors of the Department of Energy. In 1946, the Atomic Energy Commission (AEC) was created, and took over from the U.S. Army its contracts with General Electric, the University of California, and other organizations that had managed the World War II laboratories relating to nuclear energy development. These laboratory facilities became known as Federally funded research and development centers (FFRDCs). Under pressure from the Congress to accelerate the quest for practical and economical nuclear power, the AEC continued to promote private industry participation in reactor research and demonstration projects.

The AEC promotional emphasis had a significant impact on the formation of agency regulatory policies. As AEC Commissioner Willard Libby said in 1955: "Our great hazard is that this great benefit to mankind will be killed … by unnecessary regulation." While clearly aware of the need to protect public health and safety, many AEC regulators shared this anxiety, that restrictive regulations would inhibit private involvement and investment in nuclear technology. In large part, however, the efforts to stimulate private participation were successful, and led to the "bandwagon market" of the late 1960s, in which the AEC was flooded with new reactor construction and licensing applications.

The early 1970s produced a swift turnaround. Questions related to radiation exposure limits, thermal pollution, and the effectiveness of emergency core cooling systems garnered growing negative public attention. The narrowly focused AEC response to the National Environmental Policy Act of 1970 (NEPA) came under heavy criticism from environmentalists, who mounted a fierce lawsuit and dealt the agency (and the nuclear energy industry) a severe blow through the July 1971 ruling on the Calvert Cliffs nuclear units. As each new concern emerged, anti-nuclear rhetoric focused increasingly on the dual responsibilities of the AEC, which involved both promoting and regulating nuclear technology.

With the Arab oil embargo and the energy crisis of 1973-74, President Nixon asked the Congress to create a new agency that could focus on – and presumably speed up – the licensing of nuclear plants. The result was the Energy Reorganization Act of 1974, which abolished the AEC and created the Nuclear Regulatory Commission as the safety regulator of civilian nuclear power facilities. Promotional activities, nuclear weapons programs, and the infrastructure of large, multi-purpose national laboratories became the province of the Energy Research and Development Administration (ERDA), which in 1977 became the Department of Energy.

In the ensuing years, the nuclear power industry suffered a severe loss of public trust due to the 1979 accident at Three Mile Island (TMI) and, seven years later, the accident at Chernobyl. Both events were lightning rods for public distrust of nuclear safety in the civilian industry, and the TMI accident in particular resulted in significant NRC requirements for safety upgrades throughout the industry. Interestingly enough, however, public focus on nuclear safety concerns at DOE facilities – which essentially were self-regulated and able to keep a quieter profile – was later in coming. Only with the cessation of the Cold War, as the DOE became more open to public scrutiny and significant environmental and safety issues became evident, did public and Congressional pressure begin to build for bringing DOE nuclear operations under external safety regulation.

In 1994, legislation was introduced in the U. S. House of Representatives which would have subjected nuclear safety of new DOE facilities to immediate external regulation, and which would have created a stakeholder group to study the external regulation of existing facilities. As an alternative to that approach, Hazel O'Leary, then Secretary of Energy, created in January 1995 the Advisory Committee on External Regulation of DOE Nuclear Safety, which recommended that essentially all aspects of safety at DOE nuclear facilities be regulated externally. Secretary O'Leary then created the DOE Working Group on External Regulation to provide recommendations on report implementation. The primary recommendations of the Working Group were (1) that the NRC should be the external nuclear safety regulator, and (2) that the transition to external regulation should be phased in over time.

Both the Advisory Committee and the Working Group concluded that the transition to NRC regulation would involve significant legal, financial, technical, and administrative adjustments for both agencies. Given the wide variability in facility types and hazards, the Working Group recognized that the "one-size-fits-all" approach to regulation would not work, and did not attempt to outline fully the structure or method of external regulation. Thus, in early 1997, substantial gaps remained in the information and analyses on how external regulation should be implemented. As the NRC Chairman at that time, I began to work with Secretary O'Leary, and shortly thereafter with DOE Secretary Federico Peña, on an approach that would explore external regulation options through the use of a pilot program.

The pilot program was established through a November 1997 NRC/DOE Memorandum of Understanding (MOU), signed by Secretary Peña and myself, designed to provide a comprehensive framework to support legislation for the external regulation of certain DOE nuclear facilities or classes of facilities. By January 1999, pilots had been completed successfully at three facilities: the Lawrence Berkeley National Laboratory, the Oak Ridge National Laboratory Radiochemical Engineering Development Center, and the Savannah River Site Receiving Basin for Offsite Fuels. Regulatory concepts were tested at each facility through simulated regulation, evaluating the requirements, procedures, and activities of the facility against the standards the NRC believed would be appropriate.

DOE and NRC conclusions from the pilot project differed sharply. The DOE concluded that the value of a transition to external regulation was not clear, because of unresolved issues such as who should hold the NRC license (DOE or the contractor), the feasibility of retrofitting older DOE facilities to NRC standards, and potential costs associated with the transition period. The NRC task force, on the other hand, concluded that most of the technical, policy, and regulatory issues involved in NRC oversight of the DOE nuclear facilities studied could be handled adequately within existing NRC regulatory structures. During my tenure as Chairman of the NRC, my belief was that NRC oversight of DOE nuclear activities would help to put those activities on a more business-like footing, could help to eliminate duplicative and sometimes conflicting safety requirements, and could help to clarify certain reporting relationships.

The House Science Committee subsequently considered a multi-phased approach in HR 1656, which the Commission endorsed as an orderly approach for the transition to NRC regulation of DOE nuclear facilities. In March 2000, HR 3907 was introduced, which would have required the NRC to move directly to full regulatory jurisdiction over the entire scope of DOE activities – both defense and non-defense. The Commission testified before the House Commerce Committee that it continued to support the approach suggested in HR 1656.

Since that time, no additional significant legislative activity has occurred related to external safety oversight of the DOE; however, in my view, this is primarily because emergent DOE security concerns have eclipsed temporarily the focus on safety oversight. In the security arena, as you are aware, the 1999 report of the Presidential Foreign Intelligence Advisory Board (the "Rudman Report") recommended specific organizational changes involving DOE nuclear weapons functions and laboratories. These recommendations were given extra impetus by the emergence of additional security issues. The National Defense Authorization Act for FY2001 (Public Law 106-65) established the National Nuclear Security Administration (NNSA) as an autonomous agency within the DOE to handle its national security programs, including the weapons laboratories.

From my perspective, the lesson to be learned from the focus on DOE security oversight and the external regulation of nuclear safety is, in essence, the same lesson that led to the abolishment of the Atomic Energy Commission. That lesson, simply stated, is that promotion and development on the one hand, and regulation (whether for safety or security), on the other, do not mix. The self-regulation of highly complex scientific operations will suffer inevitably from conflicts of interest, either real or perceived, given the inherent risks involved – whether those risks relate to public safety, environmental protection, or national security. This lesson has been stressed repeatedly in global efforts to establish a culture of nuclear safety: as we repeatedly emphasize to developing countries or members of the Former Soviet Union, a stable national nuclear regime must have, as an essential element, an independent safety regulator with the authority to hold the operating organization accountable. The same logic holds true for DOE nuclear facilities and the national laboratories. Until a structure for external safety regulation is established, the DOE and the national laboratories will continue to undergo criticism as a self-regulated entity.

III. Clear Strategic Vision: the Lesson of an Evolutionary Mandate

The third lesson derives from the historical evolution of the DOE mission. In the days of the Atomic Energy Commission, the most significant thrust of U.S. energy policy was in fact related to expanding the use and capabilities of nuclear energy. Only after the national energy crisis of 1973 did the Federal government move to broaden decisively its national energy policy. Both the Energy Reorganization Act of 1974, which resulted in ERDA, and the DOE Organization Act of 1977, which passed the ERDA functions to the newly created Department of Energy, placed strong emphasis on the integration of major energy resource functions in a single organization, to ensure the security of the national energy supply.

A number of the studies and hearings of the past decade have focused on whether this DOE mission is still relevant – and, if not, what this change implies about the validity of the organization as a whole, in terms of its other missions – such as its long-standing role in nuclear weapons research, testing (real or simulated), and maintenance. This portion of our equation grows even more complex if we consider the changing focus of the national laboratories over the past two decades. Partnerships with industry and the academic sector, encouraged by Congressional statutes, have shifted the balance of laboratory research and collaboration toward supporting commercial product development. With the end of the Cold War came expanded awareness of the need for environmental restoration of legacy sites – and, together with a strong emphasis on maintaining the global competitiveness of U.S. industry, a shift in the balance of applied research and development toward non-defense-related activities. The emergence of climate change concerns has strengthened the support for renewable energy technologies, and the recent energy shortages in California have provided a dramatic platform for re-examining the overall health of the national energy supply.

For a Federal contractor, this evolving array of research and development needs represents a wealth of opportunity. For DOE management, however, this complex web of missions – related to national security, energy supply, science and technology, and environmental restoration – symbolizes a dynamic, often shifting landscape of priorities, partnerships, reporting chains, and responsibilities. A recurring theme in the studies and reports of recent years has been that the DOE mission has become diffuse, that its goals have become redundant with those of other Federal agencies, that the structure of the organization is confusing and inconsistent, and that many groups within the Department have little or no accountability.

What is the lesson suggested by this convoluted assortment of missions? More than perhaps any other Federal entity, the Department of Energy and its subsidiary organizations – each lead program secretarial office, each field office, each of the 9 multi-program laboratories and 13 smaller laboratories – should be infused with a clear strategic vision. By “clear strategic vision,” I mean the consistent application of sound business principles – clarity of mission, defined objectives, concrete strategies for achieving those objectives, clear measures against which to monitor organizational success, performance-based accountability, and transparency to the public. The management reforms initiated by Secretary Richardson in early 1999 were, at a minimum, a step in the right direction, establishing clear reporting chains and performance-based management objectives at the level of the lead program secretarial offices. But the clarity of strategic vision must extend to every level of the Department, to the field offices, the laboratories, the university and industry partnerships, the front-line supervision, and the Federal employees and contractors who perform the work.

This management and operational vision is particularly essential because of the unique organizational nature of the DOE. As we learned when the NRC was exploring the feasibility of external regulatory oversight, the DOE and the national laboratories cannot be either regulated or operated successfully according to a “one-size-fits-all” approach, because the DOE is less a single organization than a collection of diverse organizations. In addition, as we have shown, the DOE mission is subject to continuous evolution and shifts in emphasis, based on changes in the national security outlook, energy demands, support for the competitiveness of U.S. industry in the global marketplace, or even the political leanings of a given Administration. But the dynamic character of this mission is not a fault; it is a feature that was inherent in the original vision of Vannevar Bush and President Roosevelt, of an organization that could mobilize rapidly the scientific and engineering personnel and resources to adapt to the changing priorities of the nation.

It is this very dynamism that demands a clear strategic vision. Each laboratory or division must understand its own unique objectives and strategies clearly, and must know how those objectives and strategies link to the larger mission of the Department. Only with this approach can the various components of the DOE remain diverse and still achieve clear lines of accountability. The successful implementation of a clear strategic vision, in fact, would make the DOE and the national laboratories far more adaptable to shifts in Congressional and Administration priorities, and far less susceptible to the frequent calls for the re-distribution or elimination of DOE functions.

The advent of the National Nuclear Security Administration (NNSA) provides a unique opportunity for DOE and the weapons labs to step back, take a new look, and develop that strategic vision and the planning and internal restructuring that naturally flows from the vision.

Summary and Conclusion

In summary, I have tried to outline three lessons which, from my perspective, can be derived from a review of the history of the DOE and its predecessor organizations. First, the research and development priorities of the DOE and the national laboratories should continue to maximize the productivity and economic advantages achievable through inter-sector collaboration. Second, given the inherent safety and security risks involved in DOE activities, the functions of promotion and oversight must be separated, because self-regulation will lead inevitably to a loss of credibility. And third, if the DOE and the national laboratories are to maintain successfully their diverse and dynamic mission, it will require the implementation of a clear strategic vision at every level of the organization.

What I have not done so far in this presentation is to make predictions – but I believe I can conclude safely with two. First, there should be no anxiety, within the DOE or the national laboratories, regarding the continuing need for investment in scientific and technological research in the areas of the DOE mission. None of the recent Congressional proposals have called for the elimination or significant reduction of the three nuclear weapons laboratories, and it is unlikely for that to change under the present Administration. Similarly, the demand for continuing research and development of energy supply technologies is not likely to diminish soon. Environmental restoration remains high in the public consciousness, and will continue to be a priority. And while Federal investment in science and technology could take various forms, the demonstrated benefit of leveraging that investment speaks strongly for the continuation of partnerships with industry, academic institutions, and international organizations.

My second prediction is a statement of encouragement for all those whose futures are tied to the future of the DOE and the national laboratories. As the comedian Steven Wright has said, “If you’re not part of the solution, you’re part of the precipitate.” The inference is that the factors influencing your future are not out of your control. The formation and implementation of a clear strategic vision can occur successfully at any level of the organization. To the extent that you are able to define clearly the strategies and objectives of your group, your division, your laboratory, you will increase your ability to ensure a future for your portion of the organization. If a culture of clear strategic vision can take root and begin to permeate the DOE and the national laboratories, then the solution to our equation indeed suggests a bright and enduring future.

Thank you.